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Carnation Culture

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OHIO
AGRICULTURAL EXPERIMENT STATION
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Carnations at the Ohio Experiment Station showing a good crop of buds

CARNATION CULTURE

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INTRODUCTION

Carnations have long been considered one of the most important cut flower crops. This is due to their lasting quality before and after cutting, their fragrance, and the continued yield from plants once established. Due to prejudices and the fact that carnations are not extremely profitable as compared to some cut flower crops when considering the space occupied, interest in this crop has declined in some localities. However, the carnation is bound to regain its former importance, and we feel that its merits will win for it even greater popularity.

This bulletin is a sort of progress report to stimulate interest in the carnation until time will allow a more complete publication.

PROPAGATION

New varieties of carnations are grown from seed. The commercial crop of named varieties is propagated by cuttings. The cuttings usually are taken from the plants at the time they are producing flowers. Some carnation growers who specialize in the production of cuttings for sale grow benches for propagating purposes only, as is necessary with varieties such as Laddie and Pink or White Delight, but this is not the general practice. The majority of varieties are grown in greenhouses for only one cutting season. Some growers hold over varieties like Laddie that are difficult to propagate due to the small number of cuttings produced for the second season. However, it is generally agreed that greater freedom from disease, better quality, and better returns are secured from the newly propagated plants when the cuttings can be secured without difficulty.

The older authors recommended that the cuttings be taken in February or March. The practice now is to take cuttings early, November or December, and apparently better results are secured.

In 1928 cuttings of the Ward variety were taken from the cutting bench in a well rooted condition in January. Another lot was removed early in March in a similar state of development. The average yield per plant and stem lengths of these two lots are shown in Table 1.

Additional data are being gathered to determine more definitely the best time to take carnation cuttings. The evidence to date shows that early propagation is preferable. A larger plant with more breaks is secured, and the later propagated plants do not seem to overcome this advantage, unless it be late in the spring when prices have dropped.

TABLE 1.—Different Dates of Propagating Carnations

	Blossoms per plant	Average stem length
	No.	*In.*
Ward, propagated in January	12.4	21.0
Ward, propagated in March	9.5	21.2

A good cutting is from 3 to 5 inches long, of good disease-free material, and is in a vigorous growing condition. The former practice was to remove part of the foliage before putting the cutting in the propagation bench. Table 2 gives the results from 1000 cuttings trimmed "light" and 1000 trimmed "heavy" before putting in the cutting bench and from 1000 placed in the cutting bench just as they were removed from the parent plants. Mrs. C. W. Ward was the variety used.

TABLE 2.—Trimmed vs. Untrimmed Carnation Cuttings

Number placed in bench	Degree of trimming	Number rooted	Percent rooted
1000	None	946	94.6
1000	Light	934	93.4
1000	Heavy or regular	922	92.2

From these figures it is evident that trimming the cuttings is not advisable under the conditions of this experiment. No difference was noted in prevalence of disease, as has been mentioned by some authors; the only advantage for the untrimmed cuttings being the better percentage of rooting and a tendency to grow off quicker.

Sand is the common medium used in the cutting benches. Experiments during the winter of 1927-28 showed the superiority of this medium. Slag, sand, and combinations of these with sphagnum moss and peat moss were tried to determine the best medium for the rooting of the various types of cuttings. The results of this test are given in Table 3.

From these figures it is evident that both sand plots were good, but that a large percentage of rooting was secured in all of the

plots. With carnations, as with other crops worked on, the treatment given the cutting bench has proved of greater importance than the medium used.

TABLE 3.—Response of Different Media on the Rooting of Carnation Cuttings

Plot	Media	Cuttings	Rooted	Av. temperature of media
		No.	*Pct.*	*Degrees*
1	Sand	100	98	60
2	Sand and sphagnum	100	97	60
3	Slag	100	95	62
4	Sand and peat	100	93	62
5	Slag and peat	100	92	63
6	Slag and sphagnum	100	91	61
7	Slag and sand	100	90	61
8	Sand (used second time)	100	67	60
	Average		94.1	

If good cuttings are selected, and the bench receives the proper care after they are placed, as to watering, shading, and temperature, no difficulty should be encountered in rooting a good percentage of the cuttings. It may be needless to add that one should use a fresh medium for each lot of cuttings, as it is a worthwhile means of preventing "damping off".

Figure 1 shows the cuttings as taken from the bench. Where peat was used it will be noted that the roots seem larger. This is due to the increased amount of the media that the roots held when taken from the cutting bench.

The cuttings in this particular lot were placed in the bench February 15, and removed in the condition noted March 12, which indicates that good rooting can be secured in four weeks. The temperature of the surrounding air was 50 to 55° F. at night while a soil thermometer placed so as to record the temperature of the top 2 inches and the bottom 2 inches of the media gave the following readings:

TABLE 4.—Temperatures Top and Bottom of Media, Degrees Fahr.

Place of reading	Slag	Slag and sand	Slag and sphagnum	Slag and peat	Sand	Sand and sphagnum	Sand and peat	Sand
Top	57	57	58	58	58	58	59	58
Bottom	62	61	61	63	60	60	62	60

It was noted that some media hold water much longer than others. The plot that contained half slag and half peat required but 13 gallons of water after the cuttings were put in, while the

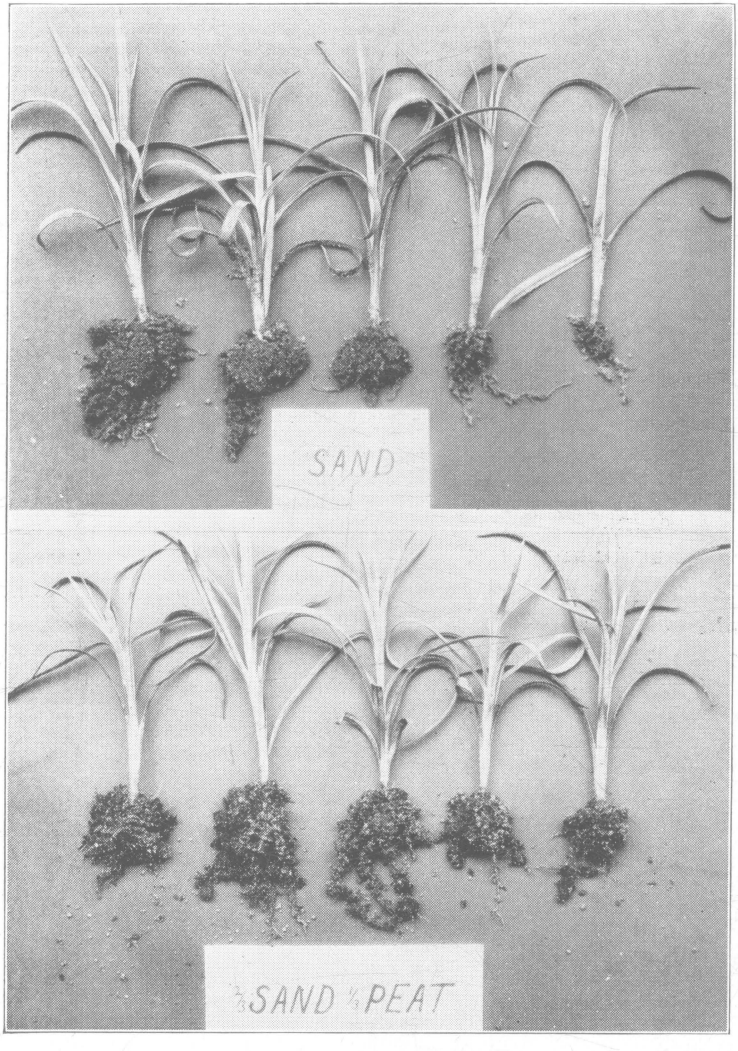


Fig. 1.—All of the media gave good percentages of rooting, if properly treated

slag plot required 25½ gallons. Each plot contained 9 square feet of bench space. From these figures one readily sees that the water requirement of the different media differs greatly, and that water has to be applied according to the porous nature of the medium used.

Some varieties were found to root more readily than others. The average number that rooted under similar conditions is given in the description of varieties. Betty Lou, Jewel, and Hilda rooted 100 percent, while Pink Delight, Pink Eldora, and Laddie were comparatively hard to root.

POTTING THE ROOTED CUTTINGS

After they have rooted sufficiently, or when the roots are from ½ to 1 inch long, the cuttings should be taken from the cutting bench. There are many ways of treating them, but they are most commonly potted. Several mixtures of compost, sand, and peat have been tried, with no marked advantage for any one mixture. The main requirement is a good sandy loam compost that is not too rich in plant foods nor too heavy. Ordinarily 2¼- or 2½-inch pots are used for the first potting. Carnations do not want to be potted very firmly.

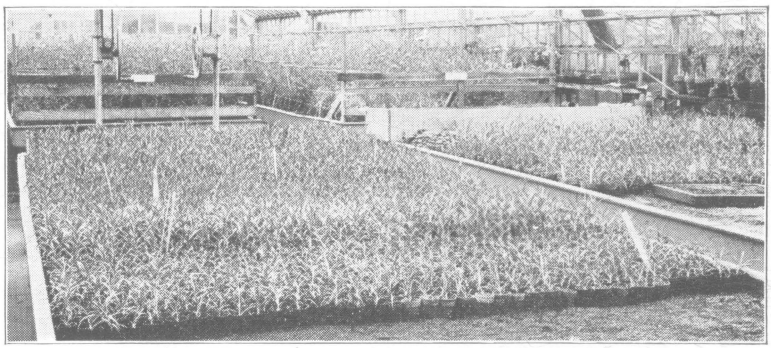


Fig. 2.—Carnation cuttings in 2¼ in. pots

Great care should be given the plants in the small pots to see that they do not get pot-bound. No experimental data are required to convince one who has seen young plants become pot-bound, hard, yellow, and stunted in growth, that these plants never again equal plants that have been kept in a vigorous growing condition. Shift into 3-inch or larger pots at the first indication of checked growth or a pot-bound condition.

Care should be exercised when potting carnation plants not to set them too deep, as many will die. Over-watering newly potted plants also proves fatal to many of them.

Due to the Easter rush, the starting of annual seedlings, and the like, the young carnation plants are often neglected. On this account poor plants, which never are very profitable, often are benched. It is important to avoid this if one wishes to secure maximum returns for the crop.

Other methods of treating the cuttings when they are removed from the sand are to place them in flats of soil where they grow until planted in the field, or to grow them 3 by 3 or 4 by 4 inches in shallow greenhouse benches.

FIELD- OR POT-GROWN PLANTS

Carnations may be set in the field as soon as danger of heavy frosts is past, or they may be carried in pots until they are put in the benches or beds. The general practice has been field culture. Advantages claimed for field culture are a firm growth, and greater disease resistance; for pot-grown plants, an earlier blooming period and better control of the growing conditions.

Both methods prove satisfactory if the proper conditions are provided for the plants. If the plants are to be field-grown, the soil should be a medium rich, friable loam; the plants should be set in the field early; they should receive no great check due to too much or too little plant food and water; and they should be benched early and with great care. Many plants are lost from rots apparently contracted in the field or when they are benched. To overcome the trouble at the time of benching care should be taken in lifting and resetting the plants not to injure them. They should not be set too deep when put in the benches or beds, as this may cause stem and branch rots.

Watering the newly set plants is also extremely important. It is less difficult with pot-grown plants. Disease apparently is much worse when the temperature is high and there is an abundance of moisture. It is impossible to keep the temperature down at the time carnation plants should be benched, so the watering should be just enough to keep them from wilting. Syringing is necessary to keep down the red spider. Some growers recommend watering very early in the morning or late in the afternoon to avoid moisture in large amounts during the heat of the day, but this method has not been tried at the Station. It may prove a help to some. A light shade of whiting, or other material is often recommended at the time the plants are benched.

A test was carried during the spring and summer of 1928 on the height to top the plants to determine whether low or high pinched plants are more susceptible to stem rot. As only 4 plants of the 1500 under test developed stem rot no data were obtained. The test is discussed under "Shaping".

If the plants are to be pot-grown they should not be allowed to become checked in growth by lack of potting or water, and they should be sprayed regularly with a good fungicide and contact insecticide to prevent disease and insect infestation. Plants at Wooster taken from the cutting bench on March 12, 1928, repotted April 15, and set in the benches June 16 and sprayed every two or three weeks with a 4-6-50 solution of bordeaux mixture with Derrisol as a spreader and Nicotine for a contact insecticide, gave excellent plants. No stem rot developed in them, altho many growers who practiced field culture were troubled with stem rot that probably developed due to the wet weather in June and early July, causing a scarcity of plants in Ohio in the fall of 1928. No disease or insect trouble of importance has developed on the plants in the Station greenhouses with the exception of rust on Betty Lou and Early Dawn, which are very susceptible varieties as grown at Wooster.

In summarizing the two methods—if the grower has outside irrigation, a well drained location, and moves the plants from the field to the benches in a proper manner, we believe the field-grown plants would be satisfactory, particularly so if the grower is inclined to neglect his pot-grown plants during the spring rush. However, more certain control of the growing conditions is possible with pot growing and less loss will be encountered in benching. Greater yields during the mid-winter months are secured from pot-grown plants set in late spring or early summer. More plants are pot-grown each year, and it is increasing in popularity.

There are so many questions involved one should try both methods and determine for himself which is the more satisfactory under his particular conditions.

SOIL FOR CARNATIONS

The soil for carnations should not be of too heavy type. Tho we have no figures to support the statement, observation leads to the belief that the carnation prefers a porous, rather open soil. A medium loam with an abundance of humus or organic matter seems to give the best growth. More careful fertilization and water control is possible in this type of soil, and a better root development is secured, which seems essential for the best results with carnations.

Whether the soil be acid or alkaline seems to have little importance as long as extremes are not encountered. Table 5 shows the 1927-28 results of growing carnations in different degrees of acidity and alkalinity. This soil was a silt loam of low organic content, selected because it was naturally very acid. Lime and aluminum sulfate were added to this soil to keep the desired reaction in the plots. Akehurst was the variety used, and 12 plants were grown to a plot.

TABLE 5.—Carnations Grown on Soils of Different Reactions

Plot	Reaction	Flowers per plant	Diameter of flowers	Stem length
	pH	*No*	*In.*	*In.*
1	5.0, very acid	7.9	2.4	21
2	5.5, acid. ..	9.7	2.6	22
3	6.0, moderately acid ..	8.6	2.6	21
4	6.5, slightly acid	9.8	2.5	22
5	7.0, neutral. . .	9.6	2.5	22
6	7.5, slightly alkaline .	8.8	2.5	22
7	8.0, moderately alkaline	9.0	2.4	20
8	8.5, alkaline	9.7	2 5	21

From these figures it is readily seen that there is no one soil reaction that is particularly desirable for the production of number of flowers, diameter of flowers, or stem length. The range of reaction normally found in the greenhouse soils of Ohio is included in the range of these plots.

During the 1928-29 growing season a similar number of Red and White Matchless carnations were grown in the acidity plots, verifying the first year's work in that no particular preference was shown in either number of flowers or stem length.

OLD OR NEW SOIL

The common practice is to grow the plants in raised benches. However, some are successfully grown in raised beds, but the crop is usually later in maturing, and such careful control of fertilizers and watering is not possible.

Many succeed in growing several crops of carnations in raised benches without changing the soil. The Illinois Station reports that after 10 years there was only 8 percent decrease in yield from the use of old soil. This decrease was not progressive after the first year. The Rhode Island Station found a decrease of 5 percent under similar conditions.

The results at Wooster have shown greater decreases. During the year 1925-26 when the soil was a fresh compost, the average yield per plant on the 15 different fertilizer treatments under test

was 10.7 flowers. On the same plots the average yield in 1926-27 was 6.2 flowers per plant. For the year 1927-28 the yield per plant was only 2.9 flowers.

These figures are very low, particularly those for 1927-28. It must be remembered that nothing was added to this soil for the three-year period except the fertilizers in the plot treatments. On many of the plots the cut was decidedly poor, whereas none of the plots gave anywhere near a good commercial cut during the 1927-28 season.

Due to these low yields and the greater possibility of trouble from insects and diseases, we do not recommend as a general practice keeping the soil in the carnation benches for more than one season. If one is successful with old soil he could not possibly afford the cost of changing the soil, but he would be taking a greater risk, and a reduction in yield.

DISTANCE OF PLANTING

Tests are being conducted at Wooster to determine the best planting distances for carnations. Many things are involved in this problem, among which variety, soil, size of plant, and the general culture given the plants are the most important.

Indications to date favor the closer planting distances. If the crop is full supported so that proper cultivation and insect and disease control are possible, the plant can be fertilized to take care of its nutritional requirements even tho closely set.

Betty Lou, a bushy, rust susceptible variety, would need more space than Maine Sunshine, a slender grower. A good soil properly fertilized will take more plants to a given area than a poor soil improperly fertilized. The proper distance lies somewhere between 6 and 12 inches, and we believe that each grower will have to determine for himself the best planting distances for the varieties grown. Growing conditions vary. Where one grower would get better returns from the close planting, another would fail. Close planting has a tendency to cause the plants to produce better stem length. Better returns per unit area will be secured from the closer planting distances in the majority of cases. Pot-grown plants can be set closer than field-grown plants as they are not as bushy.

SHAPING THE CARNATION PLANT

If the carnation plant is allowed to grow from the cutting unchecked, it will continue in most cases in one tall growth that will flower at the terminal, with an occasional lateral shoot starting to develop. The ideal carnation plant is stocky and has as large a

number of breaks as possible at the beginning of the flowering season. To secure a plant of this type, continued pinching is necessary from soon after the cuttings are potted the first time until it is necessary to allow the shoots to develop for cut flowers.

The practice among growers has been to pinch the newly potted cuttings from 2 to 4 inches above the surface of the ground, thereby securing a well shaped low branching plant, that is easy to support. Some growers even pinch them when they are removed from the cutting bench. Low branching plants, particularly if set too deep in the field, in repotting, or when benched, are thought to develop stem rot in a greater number of plants. To determine whether this be true one-half of the plants, Mrs. C. W. Ward variety, to be used in the 1928-29 fertilizer tests were pinched low (2 to 4 inches) and the other half high (4 to 6 inches). These plants were set in alternate rows across the fertilizer plots. As already stated only four out of the 1500 plants were lost when benched, so no figures of value were obtained on height of pinching and susceptibility to stem rot.

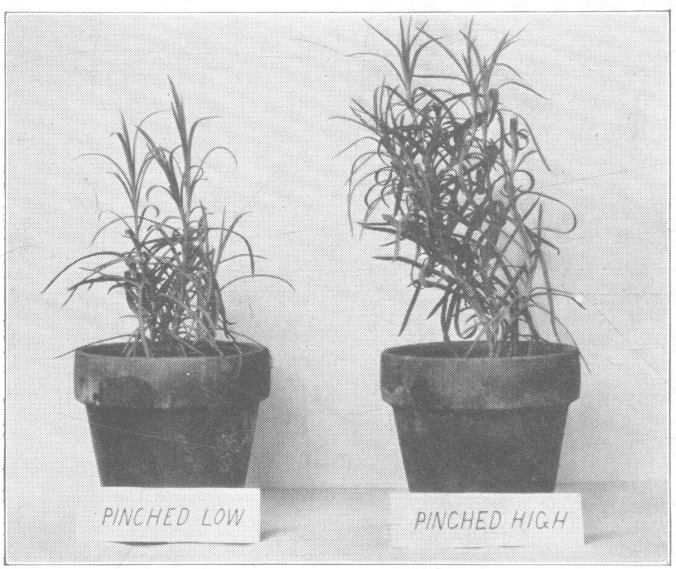


Fig. 3.—Showing the resulting growth from different heights of pinching

The cut from the plants did not show any preference for high or low pinching thruout the season. The high pinched plants gave 4915 flowers while an equal number of low pinched plants gave 4937 flowers. These high pinched plants gave earlier blossoms and up

to December there was nearly a 50 percent increase in favor of high pinching. This was overcome, however, before the end of the blooming season. Field-grown plants should be pinched relatively low to avoid damage by wind.

After the first pinching out of the terminal growth of the original cutting, the lateral shoots are pinched back as they develop. Regardless of whether the plants are field- or pot-grown, this operation should not be neglected. Observation has lead us to believe that the shoots should be pinched soon after they have reached the desired height, rather than let grow until they set buds and then pinched back to the proper height. Since breaks start more readily on succulent wood than on wood of a harder texture, more breaks are secured when the pinching is done on the succulent growths.

Pinching must continue until it is time to let the flower shoots mature. Depending on when they are benched, the pinching may be discontinued before the plants are benched or it may continue for quite a period afterward. The price of the cut flowers as well as the size of the plants should determine the time to stop pinching. As a general rule, carnations are not much in demand until the chrysanthemums and pompons are well off the market. Consequently the early short-stemmed flowers are not a high paying product. The grower could well afford to pinch late into the summer or early fall, particularly if the plants do not have a large number of shoots. If he has bushy plants with 10 to 15 breaks, and gets fair returns from the early flowers, pinching can well be discontinued early in July. It will take from 10 to 20 weeks for a blossom to develop from a newly pinched shoot, depending on time of year, rapidity of growth, and general cultural conditions.

Picking the flowers serves as a pinching after they are allowed to develop. Just how much of the stem to leave has not been determined. If too much is left the plant will soon get too high. If the stems are cut too long, so the remaining portion is only a part of an older pinching, side shoots will start slowly.

Carnation flowering stems are kept disbudded. All the axillary buds and shoots are kept removed from the upper portion of the stem. The axillary shoots from the lower portion of the flowering stems, make excellent cuttings for propagation and are the type of growth preferred by the growers. However, if early propagation is practiced (December), these shoots cannot be relied upon as the only source of cutting material unless the plants are pot-grown. Carnations grown to more than one blossom to a stem are not of a commercial grade.

SUPPORTS

Carnations are supported after they are benched by patented wire supports, or by running wire lengthwise of the rows with common twine run across the bench between the plants in the rows. The latter method is the one most commonly used. Three or four layers of this supporting material are necessary to hold the plants firmly in place for syringing, and to insure straight stems.

The first layer of supports should be as near the ground as possible and still allow room for cultivation. Rigid supporting of the plants near the ground is essential if a good job is to be done. The top wire can be from 24 to 30 inches from the bench surface.

It is much more economical of labor to place the supports soon after benching than after the plants have started an active growth.

Some growers contend that the patented supporters are much more economical of labor, and are to be preferred. This method will not allow as close planting as the wires and twine. Any method that supports the plants properly and gives straight stems is satisfactory.

CARNATION FERTILIZERS

Choosing the proper fertilizer for carnations to produce good yields is one of the more difficult problems in their successful culture. Bulletins on carnation fertilizers were published from the New Hampshire Station in 1912, Illinois in 1914, Rhode Island in 1921, and Illinois in 1927. It is difficult to get consistent conclusions from these four publications. If any can be drawn, they are that superphosphate or bone meal were beneficial, and that nitrate of soda was detrimental when applied to carnations, in addition to a good compost soil.

In 1925 carnations were set in a silt loam soil at the Station in November (due to greenhouse construction) and grown during the remainder of the year as a commercial crop. Yields per plot for the entire area were the only records kept. During the growing year 1926-27 carnations were again set in the same soil. There were seven fertilizer treatments and one check plot. Enchantress Supreme, Mrs. C. W. Ward, Edna, and Philadelphia were the varieties used (Table 6).

Only one time of application of fertilizer was tried and all of the fertilizers were mixed with the soil previous to setting the plants. Superphosphate gave the greatest number of flowers and a complete 3-12-4 fertilizer second. All of the treatments were better than the check plots.

TABLE 6.—Carnation Fertilizers, 1926-27

Plot No.	Treatment	Amount per acre	Total flowers	Flowers per plant
		Lb.	*No.*	*No.*
1	Complete fertilizer 3-12-4	1000	357	7.5
2	Superphosphate	525	386	8.0
3	Check		258	5.3
4	Complete fertilizer and air-slacked lime	2000 2000	305	6.5
5	Manure	30 tons	301	6.7
6	Sulfate of ammonia	260	301	6.7
7	Cover crop		292	6.4
8	Cyanamid	260	321	7.0

Again in the summer of 1927 carnations were set in two benches of soil that had grown carnations during the last two seasons. The soil in the benches was thoroly mixed in order that a new series of treatments could be applied, starting with a uniform soil. Table 7 gives the treatments and yields for the 1927-28 season. Mrs. C. W. Ward and Akehurst were the varieties used.

TABLE 7.—Carnation Fertilizers, 1927-28

Plot No.	Treatment	Amount per acre	Flowers per plant	Diameter	Stem length
		Lb.	*No.*	*In.*	*In.*
Bench 5					
1	Sheep manure	15 T.	3.9	2.34	17
2	Sulfate of ammonia	260	3.6	2.34	16
3	Sheep manure and superphosphate	15 T. 525	3.4	2.40	17
4	Check		2.5	2.30	15
5	Superphosphate and air-slacked lime	525 1 T.	2.5	2.24	15
6	Air-slacked lime	1 T.	2.8	2.08	16
7	Superphosphate	525	2.8	2.37	17
8	Bone meal	1000	2.5	2.28	18
Bench 6					
1	Check		2.7	2.19	18
2	Nitrate of soda	300	2.8	2.21	15
3	Nitrate of soda and bone meal	300 1000	3.8	2.29	18
4	Complete fertilizer 3-12-4	1 T.	2.7	2.15	17
5	Cow manure	30 T.	3.2	2.34	17
6	Vigoro	1000	2.8	2.32	16
7	Peat and complete fertilizer	Mulch and 1 T.	2.7	2.33	15
8	Slag and complete fertilizer	1 T.	2.5	2.05	12
9	Check		2.2	2.16	13

The average number of flowers per plant indicates the poor growth that was made on all of the plots for the season. One reason for this is that the cuttings were taken late and therefore the plants were small when set in the benches in July. The other explanation offered is that the soil, a silt loam to begin with, had lost nearly all of its humus and was not in a good physical condition during the entire growing season. As stated previously, these results indicate the value of new soil that has a good supply of humus.

Sheep manure, nitrate of soda and bone meal, sulfate of ammonia, and sheep manure and superphosphate gave the greatest number of flowers per plant; while bone meal, nitrate of soda and bone meal, and superphosphate gave the greatest increase in stem length. Altho there was not significant difference in diameter of blossoms in favor of any particular treatment the sheep manure and superphosphate, and superphosphate gave the largest blossoms. Diameter of blossoms has not been found to be a good measurement as the flowers are not fully expanded when harvested at the proper stage for good keeping.

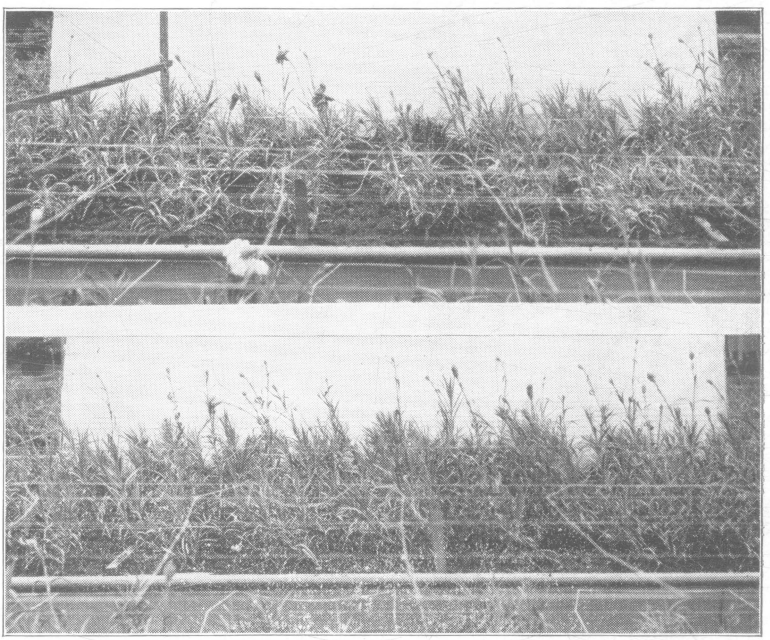


Fig. 4.—Upper, no fertilizer. Lower, sheep manure and superphosphate. Taken Nov. 12, 1927. Carnations on old soil. Shows the effect of applying humus materials to the old soil

The experiments have given some worthwhile information that may not be apparent in the tables of yield. A heavy soil low in organic content was not satisfactory for carnations. Nitrogen, superphosphate, and humus seemed to be the limiting factors in a soil for growing carnations. Good commercial yields were not secured from plants propagated too late in the spring, regardless of the treatment given them.

These preliminary experiments give some idea of the relative values of the more commonly used fertilizers and indicate the value of the different elements and humus. This work is being continued to study time of application, different carriers, and different amounts of the limiting elements.

Fig. 5.—Upper, no fertilizer. Lower, sulfate of ammonia. Taken March 14, 1929. Carnations on new soil. Inorganic fertilizers gave good results where humus was present

The 1928-29 fertilizer experiments were worked on a new compost soil, well supplied with humus. The average yield per plant for all treatments was 11.1 flowers per plant. Milorganite gave 16.6 flowers per plant. Superphosphate, air-slacked lime, bone meal, and sulfate of ammonia gave substantial increases over the non-treated plots.

Two different times of applying the fertilizer were tried in the fall of 1928. The east half of each bench received an application 12 weeks after benching the plants. The west half received no additional fertilizer until December 1. All of the plants were set in

a new soil composted from sod and cow manure. It necessarily contained a large amount of plant food. Table 8 shows the yield of the fertilized and unfertilized plants up to December 1, 1928.

TABLE 8.—Time of Application of Fertilizers, 1928-29

Plot No.	Treatment	Yield to December 1, 1928	
		Fertilized	Unfertilized
		No.	*No.*
Bench 5			
1	Sheep manure	41	21
2	Sulfate of ammonia	21	23
3	Sheep manure and superphosphate	31	12
4	Check	49	48
5	Superphosphate and air-slacked lime	24	24
6	Lime	23	24
7	Superphosphate	31	21
8	Bone meal	26	15
Bench 6			
1	Check	40	39
2	Nitrate of soda	34	38
3	Nitrate of soda and bone meal	28	33
4	Complete fertilizer 3-12-4	30	21
5	Cow manure	11	21
6	Vigoro	21	17
7	Peat and 3-12-4	20	12
8	F. and I. and 3-12-4	21	29
9	Check	26	24

Sheep manure, sheep manure and superphosphate, lime, superphosphate, bone meal, a 3-12-4 fertilizer, Vigoro, and peat and a 3-12-4 fertilizer increased the yield when applied 12 weeks after setting. The half plots receiving sulfate of ammonia, nitrate of soda, nitrate of soda and bone meal, cow manure, and F. & I. tobacco fertilizer and a 3-12-4 fertilizer did not yield as much as the corresponding half plots that had received no additional fertilizer up to December 1. These figures are in accord with the observations and opinions of many commercial growers, namely, that fertilizer containing quickly available nitrogen should be used sparingly on carnations until the hours of daylight increase in January or February. Apparently the nitrogen-carbohydrate ratio plays an important part in the nutrition of this crop.

If a good new composted soil is placed in the benches each year the grower can be much more certain of success than with an old soil. Additions of bone meal or superphosphate in the fall, and nitrogenous fertilizers in the spring may be found beneficial.

Every precaution should be taken during the winter months to secure the maximum amount of sunlight, as this governs to a great degree the yield obtained.

KEEPING QUALITY OF FLOWERS AS AFFECTED BY FERTILIZER

One of the first questions that one encounters when recommending fertilizers is the effect it will have on the keeping quality of the flowers produced. To determine this, two flowers were cut from each plot each week, one of each variety, to determine whether fertilizers affected the keeping quality. These flowers were selected for a uniform state of maturity, and were placed in tap water in living room temperature. The water was changed each day, when the stems were trimmed. Table 9 is a copy of one of the record charts for these tests. A—Akehurst, W—Mrs. C. W. Ward.

TABLE 9.—Keeping Quality as Affected by Fertilizer

Bench 5	Blossoms cut January 23	Blossoms wilted				
		Feb. 2	Feb. 3	Feb. 4	Feb. 5	Feb. 6
Plot 1				A		W
2			A		W	
3			A		W	
4			A		W	
5				A		W
6		A	W			
7			A		W	
8			A		W	
Bench 6						
Plot 1				A		W
2		A		W		
3				AW		
4				AW		
5			A		W	
6			A		W	
7				A		W
8				A	W	
9				A	W	

This particular work sheet was selected to show the trend thruout the tests. No greater differences were noted between the plots than among an equal number of flowers from the same plot. If any treatments had a tendency to be better than any others they were Plots 1 and 5 in Bench 5 and Plot 2 in Bench 6. These plots received sheep manure, superphosphate and air-slacked lime, and peat and a 3-12-4 fertilizer. Akehurst did not hold up as well as the Mrs. C. W. Ward, by two or three days in the majority of cases.

In the description of varieties it will be noted that there is a great deal of difference in their keeping quality. Those marked "poor" and "fair" only held up 12 to 18 days while some of the varieties marked "good" held in good condition for 26 days. Variety more than fertilizer, unless extremely large quantities are used, governs the keeping quality.

Care of the flowers after cutting is also very important for long keeping. Placing cut carnations in extremely low temperatures is not favorable for long keeping when they are returned to living room temperatures.

WATERING

The amount of water and the way in which it is applied are important in the culture of greenhouse crops. The general vigor of the crop, the humidity and temperature of the house, and insects and diseases are all affected by the application of water. Altho this is a difficult phase of growing to investigate, some progress is being made. Opinions only will be given here.

Some flower crops demand a great deal more water than others, but we know of few commercial cut flower crops that do not make better growth when an abundance of water is available. If the soil is too moist, however, stem rot makes greater headway with carnations and if the air is too humid rust is harder to keep in check. A proper balance between soil and air moisture has to be determined under the different growing conditions.

Carnations seem to make the best growth when the soil is uniformly moist but not saturated, and when the air is at least not dry. When and how water is applied to obtain these conditions depend on the individual grower. Some believe they get more rapid growth in winter by an alternate drying and wetting of carnation soil.

Newly benched plants, as already stated, have to be watered carefully because of stem rot. They should be kept as dry as possible without producing a wilted condition.

Syringing carnations is decidedly beneficial because of red spider, and if properly done it helps to keep the growing conditions more ideal. It is much safer to syringe plants that are well covered with bordeaux mixture, as rust does not become as prevalent. It should be done at such times only as to leave the foliage of the plants dry at night, and to keep the humidity of the house as low as possible in dark, cloudy weather.

INSECT AND DISEASE CONTROL

Stem rot, branch rot, and rust among diseases, and red spider, aphids, and thrips among insects are the most common troubles encountered in growing carnations. These are prevented by proper cultural practices and thoro preventive spraying.

Stem rot and branch rot are prevented by selecting healthy cuttings, setting at the proper depth in transplanting, by keeping

the right soil moisture during transplanting operations when the temperature is high, and by preventing injury to the plants in any of the cultural operations.

Rust is prevented by selecting rust-free cuttings, by keeping the plant well covered with a 4-6-50 bordeaux mixture with Derrisol or soap as a spreader, and contact insecticide, at all times up to the flowering period when only the lower portions of the plant need be covered, and therefore the flowering shoots are not discolored. Rust is also prevented by syringing or watering so that the plants have dry foliage at night and on dark, cloudy days.

Red spider is best controlled by syringing with cold water under pressure or with lime-sulfur. The red spider apparently only appears in great numbers when the humidity of the house is low and syringing has been neglected. If the plants are well protected by bordeaux as a preventive against rust, syringing can be done safely on bright, sunny days to keep the spider in check. Lime-sulfur is a partial control for red spider, and can be used in place of bordeaux mixture to prevent rust.

Aphids and thrips can best be controlled by tobacco contact sprays or fumigation. If nicotine and Derrisol are mixed with the bordeaux when spraying at about 2 to 3 week intervals, these insects should never become of any consequence.

RELATIONSHIP BETWEEN DIAMETER OF FLOWERS AND LENGTH OF STEMS

To determine what relationship, if any, there is between length of stems and diameter of blossoms in carnations, correlations were computed on one bench of the 1927-28 crop, as given in Table 10. There were 64 plants of the Mrs. C. W. Ward variety per plot.

TABLE 10.—Correlations Between Length of Stem and Diameter of Blossoms in Carnations

Plot	r	Er	Coefficient of variability	
			Stem length	Diameter
1	0.295	0.090	20.21	18.64
2	.076	.097	25.94	23.76
3	.219	.094	20.35	19.04
4	.788	.039	38.77	22.53
5	.262	.091	20.25	18.38
6	.338	.089	23.12	21.29
7	.086	.104	20.92	22.49

There was no significant correlation between length of stems and size of blossoms. An increase or decrease in stem length did not necessarily mean larger or smaller blossoms.

VARIETIES

LIGHT PINK

Enchantress Supreme

Plant—a bushy, vigorous grower.
Leaves—medium texture, very abundant, healthy.
Stem—medium, 17.8 inches.
Flower—good.
Keeping quality—fair.
Propagation material—abundant, 96.7 percent rooted.
Yield—14.8.

Jewel

Plant—medium.
Leaves—grassy, abundant, healthy.
Stem—medium, 17.7 inches.
Flower—excellent shade of light pink.
Keeping quality—poor to fair.
Propagation material—moderately abundant, 100 percent rooted.
Yield—15.8.

Laddie

Plant—vigorous, upright grower.
Leaves—broad, scarce, very healthy.
Stem—excellent, 21.0 inches.
Flower—good.
Keeping quality—very good.
Propagation material—very scarce, 60 percent rooted.
Yield—10.2.

Morning Glow

Plant—moderately vigorous grower.
Leaves—grassy, abundant, healthy.
Stem—short, poor, 15.7 inches.
Flower—small and rather light in color.
Keeping quality—fair to good.
Propagation material—abundant, 60 percent rooted.
Yield—16.3.

Pink Delight

Plant—medium to slender grower.
Leaves—medium texture, scarce, healthy.
Stem—good length but inclined to be weak, 19.1 inches.
Flower—good color but small.
Keeping quality—good.
Propagation material—abundant, 60 percent rooted.
Yield—15.4.

Super Supreme

Plant—bushy, vigorous grower.
Leaves—medium texture, abundant, healthy.
Stem—medium to good, 18 inches.

Flower—good.
Keeping quality—fair.
Propagation material—abundant, 86.7 percent rooted.
Yield—14.3.

DARK PINK

Akehurst

Plant—bushy, vigorous grower.
Leaves—coarse texture, abundant, healthy.
Stem—good, 20.9 inches.
Flower—a bit heavily serrated, not as good color as Mrs. C. W. Ward
Keeping quality—very poor.
Propagation material—scarce, 83.3 percent rooted.
Yield—11.4.

Betty Lou

Plant—very bushy, vigorous grower.
Leaves—medium to coarse texture, abundant. Most susceptible to rust of varieties grown.
Stem—medium to good, but inclined to be short, 16.9 inches.
Flower—good quality but perhaps an objectionable sheen to blossom.
Keeping quality—good.
Propagation material—moderately abundant, 100 percent rooted.
Yield—12.2.

Boston Ward

Plant—good, bushy, vigorous grower.
Leaves—medium texture, abundant, healthy.
Stem—very good, 19.1 inches.
Flower—excellent dark pink shade.
Keeping quality—very good.
Propagation material—abundant, 90 percent rooted.
Yield—14.1.

Mrs. C. W. Ward

Plant—moderately bushy grower.
Leaves—medium texture, moderately abundant, healthy.
Stem—good, 20.0 inches.
Flowers—good commercial dark pink, slight tendency to split.
Keeping quality—good.
Propagation material—abundant, 93.3 percent rooted.
Yield—12.4.

Pink Eldora

Plant—moderate to poor, upright grower.
Leaves—grassy, moderately heavy foliage, healthy.
Stem—medium to poor, 17.6 inches.
Flower—small.
Keeping quality—good.
Propagation material—moderately abundant, 70 percent rooted.
Yield—14.4.

Sophelia

Plant—bushy, rank grower.
Leaves—broad, abundant, healthy.
Stem—good, 18.5 inches.
Flower—good, but perhaps a bit too serrated.
Keeping quality—fair.
Propagation material—scarce, 96.7 percent rooted.
Yield—17.2.

Winsome

Plant—moderate to light grower.
Leaves—medium to fine texture, moderately abundant, healthy.
Stem—medium to good, 18.6 inches.
Flower—a bit pale for a dark pink.
Keeping quality—good to fair.
Propagation material—scarce, 73.3 percent rooted.
Yield—13.0.

RED

Beacon

Plant—moderate to vigorous grower.
Leaves—medium to fine texture, abundant, healthy.
Stem—good, 17.7 inches.
Flower—good, but inclined to be light.
Keeping quality—poor to fair.
Propagation material—abundant, 67.7 percent rooted.
Yield—14.3.

Red Matchless

Plant—vigorous grower.
Leaves—medium to coarse texture, abundant, healthy.
Stem—good, 18.3 inches.
Flower—good red, but has bad tendency to crop.
Keeping quality—very good
Propagation material—abundant, 90 percent rooted.
Yield—9.6.

Spectrum

Plant—moderate to slender, upright grower.
Leaves—medium texture, moderately abundant, healthy.
Stem—medium to weak, 19.3 inches.
Flower—good.
Keeping quality—fair to good.
Propagation material—moderately abundant, 93.3 percent rooted
Yield—16.9.

WHITE

Harvester

Plant—moderate to vigorous grower.
Leaves—medium texture, abundant, healthy.
Stem—medium to poor, 17.8 inches.

Flower—good clear white.
Keeping quality—fair to good.
Propagation material—abundant, 96.7 percent rooted.
Yield—16.7.

White Eldora

Plant—moderate to bushy grower.
Leaves—medium texture, abundant, healthy.
Stem—good, 18.1 inches.
Flower—larger than Harvester, creamy white.
Keeping quality—good.
Propagation material—scarce, 73.3 percent rooted.
Yield—17.5.

White Matchless

Plant—moderately vigorous grower.
Leaves—coarse texture, abundant, healthy.
Stem—good, 17.6 inches.
Flower—good flower with occasional pink specks.
Keeping quality—good.
Propagation material—abundant, 93.3 percent rooted.
Yield—10.3.

White Ward

Plant—moderate to vigorous grower.
Leaves—medium to coarse texture, abundant.
Stem—good, 18.8 inches.
Flower—large but inclined yellow tint with red specks.
Keeping quality—good.
Propagation material—abundant, 93.3 percent rooted.
Yield—14.0.

YELLOW

Maine Sunshine

Plant—moderate to light grower.
Leaves—medium texture, moderately small, healthy.
Stem—medium to good, 18.3 inches.
Flower—good pale yellow, white patches.
Keeping quality—fair to good.
Propagation material—moderately abundant, 72 percent rooted.
Yield—16.0.

North Star

Plant—moderate to light grower.
Leaves—medium texture, moderately scarce, healthy.
Stem—medium, 17.3 inches.
Flower—good, deep heavily serrated, yellow.
Keeping quality—fair.
Propagation material—moderately abundant to scarce, 56 percent rooted.
Yield—18.4.

VARIEGATED

Early Dawn

Plant—vigorous, bushy grower.
Leaves—medium texture, abundant, susceptible to rust.
Stem—tall but inclined to be weak, 19.6 inches.
Flower—orange yellow, splashed with light pink, splits badly.
Keeping quality—fair.
Propagation material—scarce, 96.7 percent rooted.
Yield—15.6.

Eldora

Plant—moderately vigorous grower.
Leaves—medium texture, moderately abundant, healthy.
Stem—good, 18.6 inches.
Flower—clear, white with red splashes, good.
Keeping quality—fair to good.
Propagation material—moderately abundant, 53.3 percent rooted.
Yield—13.9.

Hilda

Plant—moderate, upright grower.
Leaves—medium texture, moderately abundant, very healthy.
Stem—very good, 19.3 inches.
Flower—pink base, with red splashes, good.
Keeping quality—very good.
Propagation material—abundant, 100 percent rooted.
Yield—13.8.

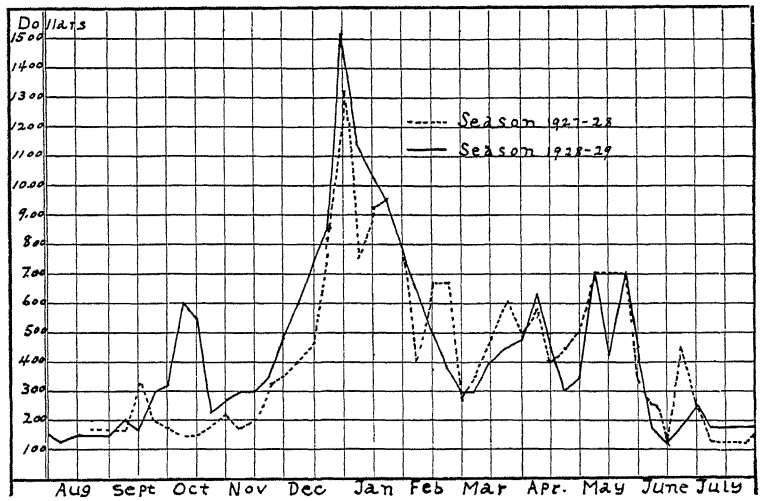
From the above results the Supremes would seem the best light pinks, Boston Ward the best dark pink, Spectrum the best red, White Eldora the best white, and North Star the best yellow of the varieties grown. The grower's conditions have a great deal to do with the success of a variety. Some growers are very successful with Betty Lou while many others have had to discontinue growing it because of its lack of vigor. Some varieties, as Sophelia, are good yielders and growers but could not be highly recommended because of their keeping quality.

Some of the newer varieties have considerable merit but have not been given a thoro trial. Among these, Pink Abundance, Spicy White, Pink Spectrum, Senator, and Woburn seem very promising.

PRICES

The accompanying graph shows the prices for the 1927-28 and 1928-29 seasons. There is a striking similarity between the trend that the prices took for the two seasons. The highest prices for both seasons were reached during the latter part of December and

early January. Any treatment that will increase production at this time would be highly profitable. Yields at Wooster increase up to December, then decrease thru January and February, reach their maximum in March and April, and then decline. This was



true on the majority of the plots, and it has been found impossible to produce the high yields during the short winter days by any fertilizer treatment. As already stated, sunlight seems to be the limiting factor.

SUMMARY

1. Early propagation of carnations is desirable.

2. Carnations root readily in several different propagating media if they are properly handled.

3. Trimming cuttings heavily before placing in the bench is not desirable.

4. Young plants should be so handled that their growth is checked the least possible amount at any time.

5. There is little preference between field- and pot-grown plants if both are properly grown. Pot grown should yield heavier in mid-winter.

6. Carnations prefer a porous, open soil that contains a good supply of humus.

7. Carnations grown in raised benches should have the soil changed each year.

8. Better returns per unit area were secured by close planting.

10. Carnations should be well supported to insure straight stems and easy culture.

11. Nitrogen (applied during bright weather of spring and fall), superphosphate, and humus seemed to be the limiting soil ingredients for successful carnation growing.

12. The keeping quality of carnations was not materially affected by fertilizers used in reasonable quantities. Variety and treatment before and after cutting govern to a great degree the keeping qualities.

13. Insects and diseases on carnations can be controlled by good culture, sanitation, and preventive spraying.

14. Carnation varieties differ a great deal in regard to yield, keeping quality, strength of stem, disease resistance, type of growth, and other characteristics. Descriptions of the more common commercial varieties are given.

15. Prices of carnations are highest during December and January.

16. There was no correlation between length of stem and size of blossom with carnations.